How To Make A Song?

The mystery of music explained in simple language

by Uwe Freising

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Preface

From the tender age of 16 I wanted to compose music. But I didn't know how to do it. I learned to play guitar but I stayed a poor player. In school, I had learned about Bach, Mozart and Beethoven. Well, I should have learned but I was not interested in those guys at that time. The teacher was ignorant of all music that happened after Beethoven. For her, even Mozart was a bit too modern. So I decided not to listen what she said.

I bought myself a self-teaching book for guitar. This book avoided nearly all musical theory what I liked. There were also songs in there. In fact, it listed just the words and had chord symbols written above them. It didn't use notation. Another plus.

I started to write my own songs. I wrote down the words and tried out simple chords I could master. I had no idea about chord progressions but when I look at those songs nowadays I see that I instinctlvely chose the right chords. Right means that I picked mainly chords that were alright for the key I had chosen unknowingly.

Later, I switched to composing music on my computer. I realized that you need some knowledge of the underlying theory when you are serious about doing something. I have listened to music all my life but now I began also to read some books about music theory. The music I had listened to began to sound differently. In more recent times the internet has been a great source of knowledge although a lot you can read there is awfully wrong.

This book presents in a very comprised way what I have learned along the way. I hope that I have not included major errors and misunderstandings. As I'm also a social scientist the book begins with some short ramblings on the theory of sound and the history of pop before I get down to the basics of making music.

I hope this book is helpful for you.

Uwe Freising

The author is a social scientist who has nevertheless spent his adult life as a professional software designer. In his spare time he either listens to music or tries to make music himself. His obsession with music started in the late 1970s.

Noise

With the beginning of the industrialisation noise became a steady ingredient of everyday life. Noise was seen as disorderly. Hence, music theorists created the dichotomy of noise and music. Attali says that "[w]ith noise is born disorder and its opposite: the world. With music is born power and its opposite: subversion" (Cox & Warner 2013[2004], p.7). Murray Schafer, who coined the term "soundscape", thinks that only "a total appreciation of the acoustic environment can give us the resources for improvising the orchestration of the world" (Cox & Warner, p. 30). For Murray Schafer no distinction between noise and music exists. We need to appreciate the rumble of the jackhammer rather than feel vexed by its intrusion. Reynolds sees noise as something therapeutic. He says that it can tear down the power structure in our brain. We must let it have its way. Let it overthrow the tyranny of our expectations (Cox & Warner, p.57). Again, noise is seen as an agent of disorder.

Umberto Eco thinks that the structure which can be seen in a work of art mirrors the valid structures of science and contemporary culture views. Hence, atonal music could not have possible in Baroque. The Western world believed in the New Jerusalem. Everything had to make sense. Everything was planned and supervised by the almighty god. Only the modern times in which a coherent meaning of life is absent for a large part of the population (at least in the western world), seemingly chaotic music could evolve.

We must, however, not forget that even Schoenberg's music has certain structures. And there also was a counter-movement. In the years following the Second World War, art music indeed became split into serialist (structured) and non-serialist (free) works, says Smith Brindle. "Yet in the music which was to come, structure was to become so obsessively important that to some composers it became an end in itself – so that poetry could be abandoned in favour of the beauty of mathematics" (Smith Brindle, 2003, p.20). Serialism was the return to very strict structures. In that it echoes the more and more machine-centred production processes. The creators of serialism wanted to create music in the same mechanized way. Smith Brindle has no too good opinion of those composers. He thinks that the artists has to be creative within the constraints of the system and should not be slaves of the mechanism. But these ideas were of course also initiated by the contemporary mathematical view of the world.

On the other hand, the artist ceased to be the almighty creator. Indeterminacy came into Western music. The line between composition and performance began to blur. And this development was rather independent from jazz which like all African music never has known this distinction. In Western music, the composer was the artist and the performer a mere craftsman. In jazz, it always was the improvising player that was seen as artist. The composition may have only consisted of chord changes. But even freedom needs structure. Freedom without structures is chaos. Martin argued that "[in] both science and jazz, a high value is attached to creative thinking and the

production of new ideas". He cites Thomas Kuhn, who wrote as early as 1970, that most scientists seem to be very productive within a framework of assumptions and beliefs. Paradigm shifts happen seldom (Martin, 2006). Smith Brindle argues that "all art has its formal schemes, which in the hands of some give only meagre fruit, while others reap a rich and abundant harvest" (Smith Brindle, 2003, p. 41).

From the Theremin to the Psychodynamic Music Machine

There are constantly attempts to explain the history of music as a history of music technology. Looking at electronic music, I want to exemplary rebut this technological determinism. Technology did play a role for sure. A lot of sounds would not have been possible without advances in technology. But many technologies were triggered by theories and prototypes which were created long time ago. There had to be a societal acceptance of the idea before it could be used in popular music.

Electronic music instruments exist a whole lot longer as one might think. Some guys may believe that electronic music starts with Tangerine Dream or Kraftwerk. Journalists who want to brag about their profound knowledge normally name Stockhausen and John Cage as initiators. Eventually, the trautonium, which can be seen as an early ancestor of the synthesizer, was invented as early as 1930. Moog began in the 1950s to build “real” synthesizers. It took till 1970 before the advent of the Minimoog allowed the increased use of synthetic sounds in popular music.

Tangerine Dream used from 1972 an EMS VCS 5, which was like the Mini-Moog a monophonic, analogue synthesizer. Kraftwerk, too, were a typical Krautrock band, which re-invented themselves only in 1973 as electronic pop group. If we are looking for beginnings, we should turn our sight to England. The Space Rock band Hawkwind may be considered pioneers in using electronic instruments and Keith Emerson as keyboardist of Emerson, Lake and Palmer carried a whole arsenal of keyboards around. Pink Floyd, on the other hand, were a typical guitar band. First, Syd Barrett, then David Gilmour dominated the sound of the band. It was not before 1972 that Pink Floyd used electronic instruments and Rick Wright, by all means, arguably was neither a keyboard virtuoso nor a visionary.

In Japan it took till 1974 for Tomita to release his album *Snowflakes Are Dancing*, on which he interpreted piano pieces by Debussy on the synthesizer. The Yellow Magic Orchestra, which can be seen as Japan’s answer to Kraftwerk, was not founded before 1978.

The analogue synthesizer was not the first electronic instrument that made it into popular music. Even if we ignore the Hammond organ for not being electronic enough, we have to accept the Mellotron as a precursor of the sampler. This device was already used heavily by the Beatles on *Strawberry Fields Forever*. King Crimson put it to good use as early as the late sixties and Pink Floyd had it on *Dark Side of the Moon* in 1973.

Digital samples are extremely important for the 1980s. The digital Fairlight CMI synthesizer was one of the first synthesizers available that used sampling technology. It was shipped in 1979 and found early adopters in Peter Gabriel, Kate Bush or Stevie Wonder. It was much too expensive, however, for ordinary users. The first

mass production digital synth was the legendary Yamaha DX7. It shaped the sound of popular music from 1983 onwards. The DX7, however, did not use samples but frequency modulation. In Techno and House hardware sequencers were the basic instruments. It was the Roland TB-303 – an analogue synthesizer with integrated step sequencer – that created the typical Acid House sound. Analogue drum computers like the Roland TR-606, which was internally a pattern sequencer as well, created the endless, monotonous rhythm loops.

But there was another electronic instruments which offered a totally different user interface: the theremin. It can count as the oldest of the instruments mentioned as it was invented as early as 1919. Its contemporary successor is the Etherwave Theremin, which is built by Moog. The theremin has not made it into popular music yet. The reason for this may lie in its difficult use. It is played contactless by hand and arm motions. The pitch is modified continuously without heeding Gregorian scales. It needs a lot of training to hit the desired pitch (see Chrysler 2011). You also do not know which note will sound next. Having said that, I must admit that Moog offers now a Etherwave Plus (Moog 2011), which comes with pitch preview.

More current developments in the electronic instrument sector also suffer from their inconvenient user interfaces. That may be true for the Body Synth (SynthZone 2011), which translates muscle contractions into midi commands. Other ideas like the AudioCubes (Percussa 2011) are more controllers than musical instruments – but it is open for discussion if this distinction is feasible any more.

MIT media labs are currently developing new hardware and software interfaces between humans and music(machines). One idea is to enable people without musical training to make music; another one is the use of music as part of an interactive therapy for sick people. "*The research focus of all this work is on designing computer systems (sensors, signal processing, and software) that measure and interpret human expression and feeling, as well as on exploring the appropriate modalities and innovative content of interactive art and entertainment environments.*" *(MIT Media Labs, 2011)*.

So, maybe it won't be far till we see the first full-blown psychodynamic music machine, which will turn our unconscious into sound. Bodily parameters like pulse, blood pressure, brain activity, skin resistance, transpiration level, blood parameters and muscle contractions are scanned in real-time and translated into soundscapes. But you have to be a stubborn positivist indeed if you think one can really create an undistorted, audible representation of id. The unconscious is not approachable by electrodes. There has to be interpretation in any case. And if the translation of the raw data by the music machine creates music or just a cacophony lies the ear of the listener. Many people heard only noise when they listened to Ornette Coleman's albums *The Shape of Jazz to Come* and *Free Jazz*.

The underlying philosophy is much more interesting than the technology. Everyone

follows a kind of basic philosophy, even if they can't name it. Nobody can evade the norms, values and beliefs that are linked to their social world. And that is still true if someone rebels against them. Even in that case, he or she must first acknowledge that there are values. And although the rebel may think to be alone in the struggle against the hegemony, there may be like-minded people. Waves of protests will wash over society.

The realities of the social world are of course mirrored by music. Electronic music, too, does bear witness to the state of society. It was outsiders, nerds that started it. Addicts to technology were the inventors and first adopters of electronic instruments. I would put Cage and Stockhausen into this category. There was a certain affinity to technology to be found in the early progressive rockers too. But they were strongly affected by hippie ideals as well. They favoured improvisation and experiment while they also rejected capitalism. And they didn't like to be put together in a box with charts acts which played simple 3 minutes pop songs. They saw themselves as serious artists in an Adornoian way. On the other hand, they all were heavily influenced by the Beatles, the first band which made the transition from a simple beat group to an advanced art project while still delivering nice melodies.

All of them – from Yes to Tangerine Dream, wanted to change the world. They were open-minded and positive. They named the problems of the world but were convinced that their generation was able to overcome them. Love was the answer. Make love not war. Not all generations saw the future in such a positive way.

The conceit of Adorno crumbled to dust in Warhol's studio. Warhol turned tomato soup cans into objects of art. McLuhan warned about the upcoming era of mass media. Velvet Underground put pure noise against artisan crafts. (But that was done by Sun Ra before). Kraftwerk, Roxy Music and Can were children of this pop culture. They weren't loaded with the negative energy Velvet Underground possessed, but all of them where alternative drafts to Adorno's high brow culture. Can hit the charts in 1971 with *Spoon*, a soundtrack for a television mystery film. (The film was funnily called *Das Messer* [the Knife]). Kraftwerk conquered the hit lists in 1973 with *Autobahn*. Roxy Music were permanent residents in the charts. Without these pioneers, bands like Yello, Pet Shop Boys, Soft Cell or Depeche Mode would not have happened.

The renegade keyboardist of Roxy Music, Brian Eno, created a whole new subgenre on his own in the Mid-Seventies: Ambient. This genre refers back to the elitist forefathers Cage and Stockhausen. Eno denounced pop music and composed from now on technoid, emotionless music only. A kind of music that seemed to breathe purity and prudence.

But at the same time a new generation came of age, which did neither share the optimism of their precursors nor the brittleness of Eno. The nihilism, hatched by the likes of Velvet Underground and the beat poets, discharged itself first in New York

City, then in London, and consequently all over the western world. A punk storm that washed away all the hippie dreams was its effect. And it wasn't just the Ramones, Sex Pistols and the Clash. There was a lot of experiment, and some of it was electronic. Suicide and Throbbing Gristle may act as examples here. For this generation, the fears of McLuhan had become reality. The mass media, in accordance with the corporates, had turned the people into a brainless mass of willing consumers. *Lost in the Supermarket* sang the Clash. No Future.

Upon this foundation of rage and hatred, Front 242 and others built their Electronic Body Music. EBM used machine beats just like house and techno, which grew alongside, but the basic philosophy was completely different. Nine Inch Nails carried this protest into the 1990s.

House and Techno surely were influenced by Kraftwerk (everyone says so. It must be true), but one should not underestimate the influence of Funk and Disco. House and Techno were all about groove from the very beginning. It was mainly dance music even if – as a subculture – it necessarily had a political dimension. Funk was the black counterpart to white hippie culture. Like Funk, House and Techno too were fed by a positive philosophy. The love parade was not incidentally named thus. *Free Your Mind and Your Ass Will Follow* sang George Clinton. Love was central to the Funk movement too, even if bodily love sometimes was accented by the songs. Disco was in parts openly sexist.

In the nineties all subgenres came up for air again in new constellations. The Orb, Aphex Twin and Orbital served their technoid customers with machine beats. Goa Trance and Dub reanimated old hippie dreams. Esotericism was on the rise again. Followers danced intoxicated by the beat and other substances around Stonehenge and searched for ley lines. India and chakra meditation were fashionable once more. Astralasia, Zion Train, Eat Static, Meat Beat Manifesto and others provided the soundtrack for the astral journeys. Ambient became an important subgenre and split in a lot of subsubgenres. Trip Hop and Lounge were invented for more lascivious city folks. And I haven't mention Drum'n'Bass yet – and, and, and.

The problem with categorizing music is that not even subgenres can be mapped to a certain philosophy. There are intersections and the artists do not like to be put into a box. One should not write about music. Music is an experience. Music is there to be listened or danced to. But language is the only way in which we can put meaning to our world.

How strong is the influence music has on us?

Some think that music has a spiritual power other forms of art do not have.

Murray Schafer cites Hermann Hesse in his seminal book “The Tuning of the World” (I used the German edition because the original was unavailable) with the claim that music reflects the state of society. In a well-ordered society the prevailing music is calm and structured and in times of turmoil music is grim and excited (Murray Schafer 2010 [1977] p.41).

There is some evidence for Hesse’s belief. The early 20th Century was a time of turmoil. So when Schönberg came up with atonal twelve-tone music, one world war lay behind mankind and another lurked around the corner. The rise of the futurists and their machine music and the surrealists and their weird reordering of categories were also signs for the huge upheaval that was taking place. Later, big transformations in US society were also the basis for free jazz and rock’n’ roll.

Murray Schafer extended Hesse’s claim to sounds that were generally believed to be noise. In thus, he refused to make a difference between the compositions of great artists and the sounds of the street. He believed that the soundscapes, as he called them, were not random products but willfully designed sounds. He had of course no sympathy for the rebels who reflected the societal changes in their works. He was a romantic and a conservative. He really thought that the mending of the soundscapes of the world would consequently heal the world.

In consequence, he disliked the sounds machines made. For him, all troubles started with the industrialization. The sounds of the steam engines and motor cars outpowered not only the sounds of nature but also the man-made noises from older technology. The sirens of the police now were louder than the church bells. The old order was besieged and finally overthrown. For him, this fact is root cause for all the turmoil and trouble in our current world.

Noise has always been a means to frighten enemies and now we have this constant background noise. This noise puts uneasiness and maybe even fear into ourselves. Hosenfeld (2006, p. 108) said that it is an evolutionary artifact that low sounds can fill us with terror. Our enemies in prehistoric times approached with dark noises while birdsong posed no danger to us. And nowadays, many machines (e.g air condition) issue low-frequented sounds permanently. Hosenfeld explains the instant reaction to sounds by the fact that the ear is the only sense that has a direct connection to both midbrain and brainstem (p. 97). The latter controls our vegetative nervous system.

Schulze (2008), who is an phenomologist, claims that the body is not a statue. It is permeable and changeable. Music lets the body swing. Music influences and modifies the functioning of our body and the reception of music is not absolute. It is

depending on the attributes of the room and on the psychological state we are in. We never hear the same musical piece twice.

It seems to be that both distracting sounds and silence does make us feel uneasy. Hampel (2006, p. 57) believes that silence is something the modern man is not accustomed to any more. Murray Schafer likewise claimed that stillness is associated by modern man with death. When nothing stirs, everything is dead. This lack of sound is threatening to us. We need to fill the silence with sound to get rid of that uneasiness (Murray Schafer, 2010[1977],p.411). So have we to listen to muzak the whole day to feel well?

Murray Schafer was strongly opposed to ambient music. He didn't want to cover the sounds of our surroundings but change them. He supposed that music – or sounds in general – can heal a troubled society. I think that this is a misconception. Music like all arts is a reflection of the state of society and hence cannot be an agent of change. If it were an agent, how could it then be a mirrored image of the society? Music has a direct connection to our unconscious mind. It can soothe or excite us. A changed soundscape would result in a changed society but that is not the way it works. The soundscape is a result of our society and we have to change society first. The soundscape will follow.

What's in a song?

Now how to write a song? What makes it more than just noise? How do rhythm, harmony and melody play together? I try in the following to give an overview. And what I say about songs here also is valid for instrumental pieces.

A popular song consists of parts which are repeated as requested by the composer. Hence, we use a threefold representation of a song. The song is the whole. It consists of part instances. Part instances are varied repetitions of parts. Hence, a part can be seen as description or definition holding meta information about the actual part instances. So, how to write such a song?

There are some parameters which are valid for whole song,

Tempo

Tempo is measured in beats per minute. A beat is a quarter note, 4/4 time hence has four beats per bar. Tempo does not have to be constant for the whole song but it often is.

For popular music, the rhythm is normally simpler for slower songs. But slow tempi also allow more ornaments for the bass. Slow jazz music can be rhythmically challenging.

Tempo	Description
< 20	Larghissimo
20 - 39	Grave

40 - 59	Largo
60 - 65	Larghetto
66 - 75	Adagio
76 - 79	Adagietto
80 - 107	Andante
108 - 119	Moderato
120 - 123	Allegro moderato
124 - 139	Allegro
140 - 167	Vivace
168 - 199	Presto
> 200	Prestissimo

Time signature

The time signature tells us how many beats are in each measure (bar) of the song. Song styles typically have a certain time signature. As with tempo, the time signature can change during a song but in popular music it usually doesn't.

Time signature	style
4/2	Ragtime
2/4	March, Samba, Conga, Tango, Calypso, Paso Doble, Polka
3/4	Waltz, Minuets, Scherzi, C&W, European folksongs, Bolero, Mazurka, Polonaise, Fandango
4/4 (Common Time)	Rock, Reggae, Techno, House, Soul, Funk, Disco, Hip Hop, Blues, Bossa Nova, Rumba, Salsa, Mambo, Dixieland, Swing, Boogie-Woogie, Cha-Cha-Cha, Discofox, Foxtrott, Jive
4/8	Tango
6/8	Gigue, Jig
12/8	Blues

The beats in a measure can be separated into down- and upbeats. The downbeats are the beats on which the bass drum plays, the upbeats are usually marked by the snare drum. In all genres derived from the blues, the downbeats in 4/4 time are beat 1 and 3, the upbeats are 2 and 4. Popular emphasises are:

2/4	**1 (meaning the first quarter of a bar)**
3/4	**1**
4/4	**1,3 (backbeat)**
5/4	**1,3 or 1,4 (as in Take Five)**
6/4	**1,4**
7/4	**1,3,5 or 1,3,6**
9/4	**1,4,7**
10/4 (Indian Jahptaal)	**1,3,6,8**
11/4 (awiis - Arabian)	**1,4,8**
12/4 (Indian Ektaal)	**1,3,5,7,9,11**
16/4 (Indian Teentaal)	**1,5,9,13**

3/8	**1 (meaning the first quaver of a bar)**
4/8	**1,3**
6/8	**1,4**
9/8	**1,4,7**
12/8	**1,4,7,10**

Typical for Carribean music is the clave rhythm. Claves come in two flavours. For the 2-3 clave, the rhythm instrument (often a conga) plays 5 times over 2 bars, 2 times in first bar, 3 times in second bar. In case of the 3-2 clave it is vice-versa. The clave rhythm can also be used as a counter-rhythm (polyrhythm).

Counter-rhythms often used in 4/4 time

- 3 over 2 quavers (shuffle), can also be used in 6/8 or 12/8 time
- 3 over 2 quarters
- 3 over 2 seminotes
- 5 over 4 quavers
- 7 over 4
- 11 over 4
- 13 over 4

In rock and pop music the counter-rhythms are often played by the ride cymbal while the kick and the snare drum play the main rhythm. The bass has to align with the kick drum.

Rock
The kick drum plays on the 1st and the 3rd beat. The snare marks the 2nd and the 4th beat. The bass plays on all 4 beats. This is the classic backbeat.

Reggae
Classically, the kick drum plays only on the 3, the snare on 2 and 4 and the bass is quite melodically. It uses often a 2 or 4 bar riff. Another option is that the kick drum plays on all beats. Typical, however, is the rhythm guitar which plays between the beats.

Motown Soul
The basic rhythm is like in rock but the bass and kick drum often play slightly offbeat. The bass drum and bass play either before or after the 3rd beat. The bass plays also on 2 and 4 with the snare.

Traditional Jazz
Traditional jazz has a strict structure. One player is soloing while all the other are “comping”. Comping is derived from “to accompany someone”. Traditional Jazz tends to have complex chord changes because the soloist can only use chord notes for his solo. Hence, the chords have 4 or 5 notes and chord changes are quite frequent. Traditional jazz style range from Dixieland via Swing to Bebop. Especially in the later style, drummers tend to play the basic rhythm on the ride cymbal and use the snare and tom drums for accents.

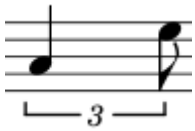
Modal Jazz
Popularized by Miles Davis, modal jazz was a breakout from the cage jazz was in the 1950s caught in. In that it paved the way for Free Jazz. The new paradigm was: “ the scale is the chord.” Modal jazz has less chord changes and is often written in “modes” rather than in minor or major.

Funk
Basically only beat 1 is a downbeat for funk. Allegedly provoked by James Brown shouting: “On the one, on the one”. There is sometimes an African two cell rhythm used. Here the kick drum plays on 1,2 onbeat and between 4 and 1 in the first bar. In the second bar it plays between 1 and 2. The snare plays on the 3 in both bars (which is contrary to backbeat). The bass often uses riffs and funk usually sports complex jazz chords with sevenths and elevenths. Bass and guitar are played like rhythm instruments. So the tend to play riffs and not harmonics.

Afrobeat
Based on Highlife, which was quite popular in 1970 in Nigeria, Afrobeat was created by Fela Kuti and Tony Allen. It builds heavily on polyrhythms (e.g. 3 over 4 strokes) and claves. It is typically a bigband style with repetitive patterns.

Shuffle
Shuffle is a rhythm where a rhythm instrument plays 3 quavers (a triplet) over 1 beat.

This gives the piece a polyrhythmic feel since the 3 quavers have the same duration as 1 quarter (or 2 quavers) of the main rhythm. The first two quavers are, however, combined to a quarter, hence you get:



Scales

All music from the European classical period (roughly Bach to Beethoven) used either major or minor scales. Each of these scales comprises 7 of the 12 available notes (c, c#, d, d#, e, f, f#, g, g#, a, a# and b). The sharp notes (e.g. c#) can also be written in flat notation as e.g. Db. We neglect the difference some purists see between sharp and flat notation. Midi (and physics) does not make a discrimination between the two. C#4 and Db4 both denote a tone with 277.18 Hz when we assume to have an equal-tempered scale. The first note of the scale is the tonic. When we start counting from zero, then each major scale has the following half-tone steps: 0, 2, 4, 5, 7, 9 and 11. For c major this is: c, d, e, f, g, a, b.

Other scales include:

Type							Scale with the same notes
major	0	2	4 5 7		9	11	c = a minor
natural minor	0	2	3 5 7		8	10	a = c major
melodic minor	0	2	3 5 7		9	11	c = a dim
harmonic minor	0	2	3 5 7		8	11	c = e augmaj
aeolian	0	2	3 5 7		8	10	c = c minorN = a major
dorian	0	2	3 5 7		9	10	d = c major
phrygian	0	1	3 5 7		8	10	e = c major
lydian	0	2	4 6 7		9	11	f = c major
mixolydian	0	2	4 5 7		9	10	g = c major
locrian	0	1	3 5 6		8	10	b = c major
blues	0	2	3 4 7		9		
dim	0	2	3 5 6		8	10	a = c minorM
aug	0	2	4 5 8		9	10	
augmaj	0	2	4 5 8		9	11	e = c minorH

Chinese	0 2 4 7 9
Blues in minor	0 3 5 6 7 10
Japanese	0 1 5 7 10

Melodic and harmonic minor scales are not used by their own in reality. They just extend natural minor. Aeolian, Dorian, Phrygian, Lydian, Mixolydian and Locrian scales are the so-called modes.

There exist a lot of other scales. Arabian, Indian and East-Asian music systems use different scales. East-Asian scales are often pentatonic. That means they just consist of 5 notes instead of 7. The Arabian music system knows 24 notes instead of just 12. Indian Ragas have complex rules. And also the equal-tempered scale is not the only the only possibility to build a musical system upon. Before Bach the tuning was different.

While symphonies in the classical age had a fixed key, the key can change in modern music for each part.

Structure

Each song in popular genres consists of parts which are repeated. The simplest example is a folk song which consists of a repetition of chorus and verse (older folk songs even had only one part which was repeated throughout). The parts are often named alphabetically by single letters. So, in our example the verse is part A and the chorus is part B. If we like to repeat chorus and verse 3 times, we could write: ABABAB. In music styles derived from blues often a third part is inserted near the end of the piece. This C part is called the bridge. Pop songs can also have an individual intro and less often a coda (end).

Classic Soul-/Rock (Verse, Chorus, Bridge)	ABABACB or ABABCAB
Sonata form (1st movement) (Exposition, Development, Recapitulation, Coda) (keys: tonic, modulation, tonic, tonic)	ABAC (or ABCD)
2nd movement slow, key: subdominant	ABA
Scherzo (3rd movement) ¾ allegro in tonic	ABACA
Coda (4th movement) in tonic	ABAC

Parts

A part in popular music is a repeatable unit which is defined by certain parameters. It has a specific harmony structure which is based on the specific chord progressions (chord changes) which are stable for all repetitions. The chord progressions should be based on the key and the scale (mode) of the song.

The length of a part is determined by the number of the bars . Parts are normally 8, 12 or 16 bars long. The intro can be shorter.

Progressions

The key and scale can be constant for the whole song. It limits the notes you can use if you haven't decided to create a twelve-tone opus. If you have opted for a tonal composition the chords should reflect the chosen scale. Another parameter which influences the mood of the composition is voicing. Voicing[1] decides in which order the notes of the chords are used. There are two different approaches for a non-standard voicing. The chord notes can be reordered preserving the chord root or using an inversion.

Example: voicing of c major with middle C (C4) as tonic.

Standard voicing	Open voicing	First inversion
c4-e4-g4	c4-g4-e5	e4-g4-c5

Typical chord progressions

Intro	I-vi-iii-V (turnaround progression)	(in C) C-Am-Em-G
Bridge	iii7-vi7-ii7-V7 (Sears-Roebuck bridge in minor)	Em7-Em7-Am7-Am7-Dm7-Dm7-G7-G7
Closing cadence	I-IV-V-I	C-F-G-C

Closing cadence

A perfect authentic cadence[2] is necessary for the song end (otherwise you need a fade-out). Songs that do not end on the tonic are not perceived by listeners as having a real end.

Tempo

A part can have a different tempo than another part. If you switch the tempo in a song, the slower or faster part should somehow stand out. So it may use a harmony, a rhythm or a melody instrument that is distinct from the ones of adjoining parts because it otherwise sounds awkward. Maybe you can slip in a short pause before

[1] voicing is the instrumentation and vertical spacing and ordering of the pitches in a chord.
[2] A PAC is a progression from V to I in major keys, and V to i in minor keys. This strong cadence achieves complete harmonic and melodic closure.

the tempo change.

Chords

A chord consists at least of 3 notes. There is no upper limit of notes it can use. The basic chords are tertian triads or tertian sevenths.

Tertian triads

These are chords based on thirds. These are the standard major or minor chords. If 0 is the chord root, major is 0- 4-7 and minor is 0-3-7. For instance, the c major chord consists of *c, e and g* and c minor of *c, d#,g*. A 3 semitones interval is a minor third, 4 semitones are a major third.

major	0-4-7
minor	0-3-7
dim	0-3-6
aug	0-4-8
b5	0-4-6

Tertian sevenths

Same as above but they include a fourth note (another third), e.g. *c, e, g, and b*. These kinds of chords are often used in tonal jazz since the fourth note is a dissonance to the root and thus adds some tension to the harmony. Depending on the scale, the most used chord variations are 7,m7 or maj7. 7 is 0-4-7-10, m7 is 0-3-7-10 and maj7 is 0-4-7-11.

major 0-4	
b13	0-4-7-8
6	0-4-7-9
7	0-4-7-10
maj7	0-4-7-11
add9	0-4-7-14
add11	0-4-7-17
7b13/5-	0-4-6-8
7/5-	0-4-6-10
maj7/5-	0-4-6-11
6/5+	0-4-8-9
7/5+	0-4-8-10
maj7/5+	0-4-8-11
6/9	0-4-9-14

minor/dim 0-3	
mb13	0-3-7-8
m6	0-3-7-9
m7	0-3-7-10
mmaj7	0-3-7-11
madd9	0-3-7-14

madd11	0-3-7-17
dim7	0-3-6-9

Quartal chords

These are chords based on fourths. These chords are often used in modal jazz. They always carry the tension note with them: e.g. *C, F, Bb*. They should only be used in connection with modes (Dorian, Phrygian etc.). Often they are extended with a fourth note which is another fourth. 7sus4 is 0-5-7-10 (e.g. *C-F-G-Bb*), which is in a different voicing 0-5-10-15 (e.g.*G4-C5-F5-Bb5*). This variant is known as "so what" chords, named after the famous Miles Davis composition. Use chords with fourths for modal tunes. Do not use the tonic (root) in the bass for the tonic chord for modal harmonies on the first beat.

sus4 0-5	
sus4	0-5-7
b13sus4	0-5-7-8
6sus4	0-5-7-9
7sus4	0-5-7-10
maj7sus4	0-5-7-11
add9sus4	0-5-7-14
add11sus4	0-5-7-17

(Quintal) Power chords

e.g. c,g,c. These chords are base on fifths. Power chords are often used in Heavy Metal.

5	0-7-12

Other chords

Other chords include sus2 chords and chords with more than 4 notes. A 2 semitones interval is known as major second or diminished third.

sus2 0-2	
sus2	0-2-7
b13sus2	0-2-7-8
6sus2	0-2-7-9
7sus2	0-2-7-10
maj7sus2	0-2-7-11
add9sus2	0-2-7-14
add11sus2	0-2-7-17

Most important chords of a major scale

Step	Type of chord	Example for a c major scale
I	<plain major> maj7	c (tonic) cmaj7
ii	m m7	dm dm7
iii	m m7	em em7
IV	<plain major> maj7	f (subdominant) fmaj7
V	<plain major> 7	g (dominant) g7
vi	m m7	am am7

Most important chords of a minor scale

Step	Type of chord	Example for an a minor scale
i	m m7	am (tonic) am7
III	<plain major> maj7	c cmaj7
iv	m m7	dm (minor subdominant) dm7
v	m m7	em (minor dominant) em7
VI	<plain major> maj7	f fmaj7
VII	<plain major> 7	g g7

Melody

Melodies in popular music (and in classical music as well) are usually based on variations of one or more motifs[3]. In classical music you often find competing melodies. Those secondary melodies are called counterpoint[4] . Although there were attempts to form a theory of how a good melody is created no theory so far was convincing. At the end of the book I will discuss one of these theories. It's the Musical Forces Theory which was the brainchild of Steve Larsen.

[3] a motif or motive is is a short musical idea, a salient recurring figure, musical fragment or succession of notes that has some special importance in or is characteristic of a composition.
[4] counterpoint is the relationship between voices that are harmonically interdependent (polyphony), but independent in rhythm and contour.

The melody has to be written for a specific instrument. A piano line may sound awkward on an organ. Basically you have of course to consider the pitch range of the instrument. Horns will need pauses in addition giving the player the chance to breathe. Very short notes are feasible on a piano they are not applicable for horns or instruments with lingering sounds. However, hovering sounds will normally not be used for a lead track. Long notes are useless for instruments with no sustain but they can be used in a piano line instead of a shorter note and a rest.

Harmony

The chords are the harmonies of the piece. Chords can be played as a whole or the chord notes are played sequential. If a chord is played in sequential style, we call this an arpeggio. Arpeggios are often used in computer music. Bass lines are often arpeggios too. However, in some musical styles riffs are preferred. A riff is a short (1 or 2 bars), melodically phrase. It is repeated without modification. The riff ignores the harmony changes.

Typical arpeggios include

- NoteUp – the chord notes are played in ascending order
- NoteDown – the chord notes are played in descending order
- Random – the chord notes are played at random
- BarUpDown – ascending order for first bar, descending for next etc.
- BarDownUp – descending order for first bar, ascending for next etc.

Some DAWs as well as some synthesizers include arpeggiators which are a means to automate the creation of arpeggios.

Bass line

The simplest bass line is an ostinato[5] bass. It repeats the tonic of the current chord at the downbeats and upbeats (normal time), at the downbeats only (half-time) or at and between the pulse beats (double-time).

A walking bass is often used in jazz music, especially in tonal jazz. Usually it is played by an upright bass (contrabass). This bass line consists of quarter notes which always are chord notes and it runs on without rests and without variation of note durations.

A shuffle bass line consists of triplets of 8ths but the first two 8ths are merged into a quarter. Since the whole triplet has the duration of a quarter this construction gives the piece a polyrhythmic feel. Shuffle bass was often used in Swing music.

While all these options mentioned above use only chord notes, a bass riff can use all notes of the current scale.

Drums

[5] an ostinato is a motif or phrase, that persistently repeats in the same musical voice, usually at the same pitch.

In analogue music, the drummer is the timegiver. In rock and soul styles the kick and the snare drum mark the beats. In styles influenced by African music, the drums are often syncopated. Which means that they do not play necessarily at the beats but also before and after the beats. As Sun Ra told his musicians: “You can play before the beat or you can play after the beat. But if you play on the beat then the whites will get you.” Some styles are heavily polyrhythmic as for instance Afrobeat. Tony Allen, who used to be Fela Kuti's drummer, said once that a good drummer has four limbs and plays something different with each of them.

In Jazz, the beat is often given by the ride cymbal.

To keep the drum line interesting, drummers often play short fills. Some of the most used drum fills are the following:

	1				5				*9*				13				**17**				21				*25*				29				32
Ride	X				X		X		X				X		X		X				X				X				X				X	
Tom																																		
Snare									X																X									
Kick	X																X	X																

1) Default-Backbeat

	1			5			*9*			13			**17**			21			*25*			29			
Ride	X			X		X	X			X		X	X			X		X							
Tom																					H			H	
Snare							X												X	X			X	X		
Kick	X												X	X												

2) Sixteenth-Fill with High Tom

	1			5			*9*			13			**17**			21			*25*			29			
Ride	X			X		X	X			X		X	X			X		X							
Tom																				H	L		H	L	
Snare							X												X			X			
Kick	X												X	X											

3) Snare-High-Low-Tom-Fill

	1			5			*9*			13			**17**			21			*25*				29			
Ride	X			X		X	X			X		X	X			X		X								
Tom																									H	
Snare							X												X	X	X	X	X	X		
Kick	X												X	X												

4) 6-Snare-High-Tom-Fill

	1			5			*9*			13			**17**			21			*25*				29			
Ride	X			X		X	X			X		X	X			X		X								
Tom																								H	L	
Snare							X												X	X	X	X	X			
Kick	X												X	X												

5) 5-Snare-High-Low-Fill

	1			5			*9*			13			**17**			21			*25*				29			
Ride	X			X		X	X			X		X	X			X		X								
Tom																								H	L	L
Snare							X												X	X	X	X	X			
Kick	X												X	X												

6) 5-Snare-High-2Low-Fill

	1			5			*9*			13			**17**			21			*25*				29			
Ride	X			X		X	X			X		X	X			X		X								
Tom																					H	H	H	H	L	L
Snare							X												X	X						
Kick	X												X	X												

7) 2-Snare-4High-2Low-Fill

	1			5			*9*			13			**17**			21			*25*			29			
Ride	X			X		X	X			X		X	X			X		X							
Tom																						H	H	L	L
Snare							X												X	X					
Kick	X												X	X											

8) 2-Snare-2High-2Low-Fill

	1			5			*9*			13			**17**			21			*25*			29			
Ride	X			X		X	X			X		X	X			X		X							
Tom																									
Snare							X														X	X	X		X
Kick	X												X	X											

9) 4-Snare-Stutter-Fill

	1			5			*9*			13			**17**			21			*25*			29			
Ride	X			X		X	X			X		X	X			X		X							
Tom																									
Snare							X														X	X	X	X	X	X
Kick	X												X	X												

10) 6-Snare-Fill

	1			5			*9*			13			**17**			21			*25*			29			
Ride	X			X		X	X			X		X	X			X		X							
Tom																							H	L	L
Snare							X														X	X	X		
Kick	X												X	X											

11) 3-Snare-High-2Low-Fill

	1				5				*9*				13				**17**				21				*25*				29			
Ride	X				X		X		X				X		X		X				X		X										
Tom																													H	H	L	L
Snare									X																			X	X				
Kick	X															X	X																

12) 2-Snare-2High-2Low-Fill

Vocals

Mixing a vocal track is tricky. Lead vocals must stand out in the mix but all to often they are drowned by loud instrumental sounds. Putting up the volume of the vocal track is not always feasible because it may produce sharp, unpleasant peaks. So we have to use a compressor to raise the loudness without producing high pitched peaks.

The lead vocals are usually the only melody instrument in a part. The requirements for a vocal melody line are much the same as for horns. The melody should consist mainly of quarters and quavers. The vocal melody is made up from phrases that behave just like declarative or interrogative sentences. The phrase ends with a pause since humans need to draw breath. For declarative sentences (statements) the melody goes down at the end, for interrogative sentences (questions) the melody rises. The range of the pitches should not exceed one octave.

Vocals have also words to it. Apart from scat singing the combination of the words has to be more or less sensible. How to write good lyrics is arguably a talent which you can't learn. Definitely you have to have a way with language. What can be learned is that you have to have one syllable for each note or one note for each syllable (whatever comes first). A syllable may in some cases be stretched over more than one note but you cannot sing more than one syllable on one note.

Instruments

Instrument Ranges

Instrument	Low	High
Bass guitar	E1	G3
Upright Bass	E1	D#4
Soprano Sax (Bb instrument)	Bb3	Eb6
Alto Sax (eb)	Eb3	G5
Tenor Sax (Bb)	Bb2	Eb5
Trumpet in C	F#3	C6
Trombone	G2	G4
Acoustic Guitar	E2	E4
E-Guitar	E2	G4
Violin	G3	G6
Viola	C3	C6
Cello	C2	C5

Octaves:

Midi	Standard concert pitch	description
0	C0	
12	C1	
24	C2	Below bass staff
36	C3	Middle of bass staff
48	C4	Below violin staff (Middle C)
60	C5	Middle of violin staff
72	C6	Above violin staff
84	C7	

The lower line of the bass staff marks G2 and the upper line- A3. The lower line of the violin staff is at E4 and the upper line at F5.

Guitar Layout

0	e1	a1	d2	g2	b2	e3	0
1	f1	a#1	d#2	g#2	c3	f3	1
2	f#1	b1	e2	a2	c#3	f#3	2
3	g1	c2	f2	a#2	d3	g3	3
4	g#1	c#2	f#2	b2	d#3	g#3	4
5	a1	d2	g2	c3	e3	a3	5
6	a#1	d#2	g#2	c#3	f3	a#3	6
7	b1	e2	a2	d3	f#3	b3	7
8	c2	f2	a#2	d#3	g3	c4	8
9	c#2	f#2	b2	e3	g#3	c#4	9
10	d2	g2	c3	f3	a3	d4	10
11	d#2	g#2	c#3	f#3	a#3	d#4	11
12	-	a2	d3	g3	b3	e4	12
13	-	a#2	d#3	g#3	c4	f4	13
14	-	-	-	a3	c#4	f#4	14
15	-	-	-	-	d4	g4	15

Above table shows the actually sounding notes. Guitar is notated one octave higher than it sounds. Note that the frets higher than 12 are hard to play because of the joint of the neck to the body of the guitar. This may vary but for acoustic guitars the neck joins the body at fret 12.

Some Guitar Chords

Lower Range

C major (1st fret)	< e1 c2 e2 g2 c3 e3 >
D major (2nd fret)	< a1 d2 a2 d3 f#3 >
E major (1st fret)	< e1 b1 e2 g#2 b2 e3 >
F major (1st barre)	< f1 c2 f2 a2 c3 f3>
G major (2nd fret)	< g1 b1 d2 g2 b2 g3 >
A major (2nd fret)	< e1 a1 e2 a2 c#3 e3>
B major (2nd fret)	< f#2 b2 d#3 f#3>
Dm (1st fret)	< a1 d2 a2 d3 f3>
Em (2nd fret)	<e1 b1 e2 g2 b2 e3>
Fm (1st barre)	<f c2 f2 ab2 c3 f3>

Gm (3rd barre)	< g1 d2 g2 bb2 d3 g3>
Am (2nd fret)	< e1 a1 e2 a2 c3 e3>

Barré

Eb7 major (6th fret)	<bb1 eb2 bb2 db3 g3 bb3 >
E major (7th fret)	< b1 e2 b2 e3 g#3 b3 >
Db6 major (6th fret)	<bb1 f2 ab2 db3 f3 bb3 >
Fm9 (4th fret)	<ab1 c2 f2 c3 eb3 ab3 >

Bass (Guitar) Layout

0	**E1**	**A1**	**D2**	**G2**	0
1	**F1**	**A#1**	**D#2**	**G#2**	1
2	**F#1**	**B1**	**E2**	**A2**	2
3	**G1**	**C2**	**F2**	**A#2**	3
4	**G#1**	**C#2**	**F#2**	**B2**	4
5	**A1**	**D2**	**G2**	**C3**	5
6	**A#1**	**D#2**	**G#2**	**C#3**	6
7	**B1**	**E2**	**A2**	**D3**	7
8	**C2**	**F2**	**A#2**	**D#3**	8
9	**C#2**	**F#2**	**B2**	**E3**	9
10	**D2**	**G2**	**C3**	**F3**	10
11	**D#2**	**G#2**	**C#3**	**F#3**	11
12	**E2**	**A2**	**D3**	**G3**	12
13	**F2**	**A#2**	**D#3**	**G#3**	13
14	**F#2**	**B2**	**E3**	**A3**	14
15	**G2**	**C3**	**F3**	**A#3**	15
16	**G#2**	**C#3**	**F#3**	**B3**	16
17	**A2**	**D3**	**G3**	**C4**	17
18	**A#2**	**D#3**	**G#3**	**C#4**	18

Above table shows the actually sounding notes. Bass (guitar) is notated one octave higher than it sounds. The electric bass guitar usually stops at g, the double bass has a wider range because the frets higher than 12 are hard to play on a bass guitar. The technique of playing is different on a (upright) double bass.

Synthesizer

A synthesizer is a hardware or software device which creates sound using synthesis. There are different method how to synthesise sounds.

Additive Synthesis

The idea for additive synthesis stems from the end of the 19th century. The first successful instrument that was using this method was the Hammond organ in 1934. Additive synthesis is based on the finding that all sounds can theoretically be deconstructed into stacked sine waves. In practice, it proved to be difficult to generate complex sound by adding sine waves. Each sine wave above the fundamental one is an overtone. Real world sounds consist of hundreds of overtones.

Subtractive Synthesis

The first instruments that were actually perceived as synthesizers by the public used subtractive synthesis. The most prominent representatives of this group are the modular Moog synthesizers which were shipped first in 1965. The compact Minimoog, which followed in 1970, was the first portable specimen of this kind. In subtractive synthesis the output of one or more voltage-controlled oscillators (VCO) are filtered by a voltage-controlled filter (VCF) and are amplified by a voltage-controlled amplifier (VCA). Moog classically used a low-pass filter which is a filter that attenuates high frequencies. The cut-off frequency, which controls the point from which the filter is active, can be modified by the user. Other notable filter types are the high-pass filter, which is the counterpart to the low-pass filter, and the band-pass filter, which is a combined low-pass and high-pass filter. The oscillators used simple waveforms like sawtooth and square. Sine waves are not widely used because they have no overtones and hence there is nothing which can be filtered out. Sometimes white or pink noise is used as input. Combining the inputs can lead to complex sounds.The Minimoog shaped the sound of many progressive rock acts of the seventies.

FM Synthesis

Frequency modulation was not feasible with the analogue synthesizers of the sixties and seventies. The electric components were not stable enough to give the needed exact input for this mathematical method. Yamaha launched a digital synthesizer, which was using FM synthesis, in 1983. The Yamaha DX7 has been the most successful synthesizer of all times.

The DX7 is famous for its inbuilt factory sounds. Especially the electric piano sound can be heard on a lot of pop albums of the time. It seems that the customers used rather the factory sounds than creating new ones because creating new sounds with FM is tricky. It doesn't work with the trial and error method (fiddle with the knobs) which may be good enough for subtractive synthesis.

For FM synthesis we need at least 2 oscillators (Cann 2011). One is called the

carrier, the other is the modulator. Only the first one is audible, the second one is used to modulate the frequency of the first. The higher the amplitude of the modulator, the more partials (overtones) are created. Each oscillator also has an envelope. The pair of them is called an operator. The patching of the operators is called algorithm. The DX7 had 6 operators and 32 fixed algorithms. The chosen algorithm decided in the DX7 whether one operator was a carrier or a modulator. The DX7 operators used only sine waves.

The relation (ratio) between the carrier and the modulator tuning decides how the output sounds. In the following I list the effects you can expect with FM synthesis when using sine waves only (Cann, 2011):

Ratio	Sound
1:0.0625	Vibrato
1:0.125	Engine-like pulse
1:0.25	Weighty bass tone
1:0.33	Another bass tone
1:0.5	Thinner bass tone
1:1	Sawtooth
1:1.33 (3:4)	Metallic
1:1:5 (2:3)	Another metallic sound
1:1667 (3:8)	Even more metallic
1:2	Square
1:2.5	Very metallic
1:3	Sharp, not metallic
1:333 (3:10)	Bell
1:4	Bright (sine)
1:6	Piercing
1:8	Metallic again

By using more than one operator pair you can build very complex sounds. Also, setting the envelopes differently for each operators can help to build complex sound. So, you can create one sound for the attack part and one for the sustain part.

FM envelopes were different from simple ADSR envelopes as used in analogue

synthesizers. ADSR stands for attack, decay, sustain and release. A, D and R points have to be movable in the horizontal direction (time). S only in the vertical direction (amplitude). The attack time is the time that passes till the sound reaches its maximum amplitude. The decay time is the time it takes to get to the sustain phase. The sustain value is the amplitude of the sustain phase and the release time is the time span the tone still sounds after the note off message(i.e. after you released the key). The DX7 had for each carrier and each modulator an independent envelope with 4 horizontal and vertical movable points (time & amplitude). Lowering the output (volume) of an operator speeds up the envelope.

Waveshaping

Waveshaping is a method where the waveform is transformed by a mathematical function (Russ, 2012). Most waveshaping synthesizers used a pre-compiled look-up table to fetch value y for source value x. One of the first notable waveshaping synthesizers was the Buchla Touche in 1978. Today's software synthesizers are fast enough to calculate even complex formulas on the fly.

Sample and Synthesis (S&S)

The Fairlight CMI shaped the sound of the first half of the eighties. The Fairlight CMI was a music computer that used samples as basis for its sounds. Bands like Human League, Erasure, Yazoo and Heaven 17 are typical examples of Fairlight based music but even interprets that were not perceived as electronic music acts used the Fairlight massively (e.g. Alan Parsons Project). The downside was that only established acts could use it since the prices for the Fairlight CMI started from $25000 for a basic model. The first affordable S&S synthesizer saw the light of the world in 1987. It was the Roland D-50, which used pulse code modulated samples as raw input for its sound. The Korg M1, which came one year later, was however the most successful S&S synthesizer of the time.

Samplers

Samplers are strictly seen no synthesizers although most of them are nowadays capable of using envelopes and effects to modulate the sample. The first affordable sampler was the Akai S900 in 1986. Samplers are used to record audio snippets (samples) and play them back. They use interpolation to transpose the source sound to another frequency.

Wavetable Synthesis

A wavetable is an array of waveforms. By sequencing through the waveforms in original or alternating order new sounds are created. The waveforms of one wavetable can also be modulated by the waveforms of another wavetable. An early wavetable synthesizer was the PPG Wave 2 from 1981. A synthesizer that cross-blended 4 wavetables was shipped in 1986 by Sequential Circuits. It was named Prophet VS and its type of wavetable synthesis is known as vector synthesis. The most modern synthesizers use wavetables in one way or the other.

Physical Modelling Synthesis

By a physically modelled wavetable some synthesizer manufacturers try to recreate the sound spectrum of a natural instrument or instrument group. It is basically additive synthesis but the partials (overtones) are all created at the laboratory. This synthesis method gives very natural sounding instruments but the downside is that the sounds are not open to big changes. The Yamaha VL1 was the first PM synthesizer that was sold. It hit the shops in 1994.

Resynthesis

In resynthesis, Fast Fourier Transformation (FFT) is used to analyse the spectrum of an audio source. By extracting the single partials of a sound a physically modelled wavetable can be built up.

Sound Morphing

By mathematical functions the spectra of two wavetables can be cross-blended. Morphing is different from mixing two sounds which most modern samplers are also capable of. In morphing, the partials of the sounds are blended. In effect, this is just another type of wavetable modulation. Harmonic Content Morphing is an example for morphing. It was first used by the software synthesizer Tone2 Firebird in 2006.

Granular Synthesis

Granular or grain synthesis uses samples as sources. Unlike a sampler, it chops up the sample into very small grains. These grains can then be modulated separately. Granular synthesis is very demanding on the hardware and has only been realised in software synthesizers. The sound programming language Csound from 1992 is an example.

How To Build A Patch?

Independent from the synthesis method, there is common ground how a patch should sound to meet the particular needs. A lead patch is different from a pad sound. And a percussive patch won't look like a harmony patch (Shepard, 2013, pp. 205). Most synthesizer have built-in effects and modulation. It is open for discussion if you should use the effects of the synthesizer or the ones of your DAW. Some say to use the built-in effects because the synthesizer can use the effects on the oscillator output while the DAW has to modify the audio signal. Others say that the synthesizer effects are inferior to the DAW effects in most cases. Modulation however is a main feature of all synthesizers but it is not suitable for all kind of patches. For a discussion of effects and modulation see the chapter “Effects & Modulation”.

Lead voice

A patch for a lead voice must stand out in the mix. Hence, we need bright sounds as source like square or sawtooth waves. It should have a very short attack time and no or nearly no decay. The sustain level is equal or close to the maximum level. Also, there's only a short release time. We don't use tons of effects on such a sound. A bit of reverb will do. A lot of modulation is distracting too. Some LFO vibrato will do. If

your synthesizer is capable to do it you should use the LFO only for longer notes.

Harmony voice

The harmony patch will play the chords, either polyphonic or as arpeggio. This voice must not dominate in the mix. We can also use bright sounding sources but with slow attack, audible decay and a longer release time. If we use it to play long, polyphonic sounds we will also want some vibrato. For arpeggios with shorter notes modulation makes not much sense.

Pads

Pads are used to fill up the mix in the background to make it sound bigger. Most of what is true for harmony voices is also true for pads. They have a short decay time with a high sustain level though. Some synthesizers offer loops inside the envelope, others have a static sustain phase. If your synthesizer has loop points you can create a loop to make the sound more interesting. Since pads are intended to produce long, sustained, floating sounds we have to add a lot of modulation to stop the sound from getting boring.

Percussive voice

Percussive patches often use square waves as a basis. They have a very short attack and no decay. The sustain level is close to zero. A short release time is also recommended. Modulation again makes no sense because the sound is too short for it.

Bass voice

What I have said about percussive sounds is basically also true for bass patches. They may have a slightly longer decay time though. You should use at least two oscillators to fatten the sound. Also, to add a low-pass filter is usually a good idea. A light distortion may make the sound more interesting. This can be achieved by slightly dephasing one oscillator or by adding drift if the synthesizer offers this.

Free Software Synthesizers

Let me add here a list of recommendable free software synthesizers. The list is highly subjective and, since the world of software changes fast, may be outdated when you read it. All listed synthesizers are available as VST plugins for Windows (some of them may also be available for Macs, but I don't own an Apple computer). VST is a plugin specification and framework from Steinberg. Most of the current digital audio workstations (DAW) can act as a VST host. DAWs capable of using a VST plugin include for instance Steinberg Cubase, Ableton Live and Renoise. I do not add the download URLs because the internet is volatile too. You can easily google for the following programs to get a download address. *www.**vst4free**.com/* is also a great source for free VST plugins.

Virtual analogue synthesizers

I prefer TAL NoiseMaker and U-he Tyrell Nexus 6. Both use subtractive synthesis. There are also a lot of emulations of hardware synthesizers available. MiniMogue is very good Minimoog emulation. Obxd emulates old Oberheim synths and Synth1 emulates the Clavia Nord Lead 2.

FM synthesis

Dexed is a fantastic emulation of the Yamaha DX7.

Wavetable

Vstwsimd23 thoroughly emulates the sound of the PPG Wave 2.

Morphing

The Tone2 Firebird used to be a commercial product but Tone2 has set it free.

Hybrid

Crystal combines subtractive synthesis with samples and soundfonts and frequency modulation. U-he Zebralette is a stripped down, one oscillator version of the commercial Zebra synthesizer. It combines subtractive synthesis, FM and waveshaping with four morphing functions (GeoMorph, SpectroMorph, GeoBlend and SpectroBlend).

Physically Modelled

Phybes is a great mallet synthesizer, Samsara KettleDrum is a timpani synthesizer and Revitar is a guitar synthesizer.

Effects & Modulation

Reverberation

Reverb is one of most used effects. In the real world every sound has a reverberation as the sound is reflected by walls and other objects. Hence, digital sounds appear synthetic without reverb.

Delay / Echo

Delay is commonly used to add spatial echoes in either rhythmic or non-rhythmic patterns.

Equalizer

An equalizer is used to attenuate or enforce frequency regions.

Compressor

A Compressor "squashes" an audio signal as it rises above a specific threshold level,

reducing its dynamic range and providing extra headroom for the signal to be boosted in volume after compression. This results in a "fattening" of the sound.

Amp(lifier)
This effect tries to simulate the sound of hardware amplification cabinets.

Chorus
Chorus adds differently pitched copies of the sound to make it richer.

Low Frequency Oscillator (LFO)
Signals below 20Hz are not audible for humans but when they are disharmonic to the audible sound they add a rhythmic pulse to the sound. The LFO produces such low frequency sounds. A LFO is mostly used to modulate pitch or amplitude. With an triangle or sine wave you can cause a rise and fall. If applied to the pitch, it produces a vibrato. If it modulates the amplitude a tremolo is produced. A square wave applied to the pitch generates a trill.

Ring Modulation
Ring modulation (ringmod) multiplies the source signal which eliminates the main harmonies and leaves only the sidebands.

Flanger
A flanger mixes two identical signals together, with one of them delayed by a small and gradually changing amount.

Phaser
A phaser splits the audio signal into two paths and then alters the phase of one of the copies. The phase changes varies over time and thus create a sweeping effect.

Limiter
A limiter clips output signals that exceed a certain amplitude.

Gainer / VCA
A gainer simply amplifies the sound.

Which effect to use when?

What to use on a synthesizer track?
Probably nothing if the synth has its own effects, Balancing right/left or surround

What to use on a sampled melody & harmony instrument?
Reverb, [Gainer] ,Balancing right/left

What to use on a sampled bass instrument
Compressor, Reverb, Balancing middle

What to use on a sampled drum instrument
Compressor, Reverb, Balancing middle (bass drum) or right/left (other drums)

What to use on a sampled cymbal instrument
Reverb, Balancing right/left

What to use on a vocal track?
Equalizer, Compressor & Reverb, Balancing middle (lead vocals) or right/left

What to use for mastering?
Equalizer, Maximizer/Limiter & Gainer

Musical Forces Theory

Larson was working for more than twenty years on his much contested theory of musical forces. His work culminated in the book “Musical Forces: motion, metaphor, and meaning in music” which was published in 2012 . Sadly, Larson died from a brain tumor soon after he had completed the book. I am, in general, quite skeptical about theories that explain things but half but Larson’s book is an inspiring read.

Larson agrees with theorists like Zuckerkandl and others that music is created in the mind of the listener. But he adds that we think about music in mainly two metaphorical ways. We see music either as a physical motion, an agent that tries to reach a goal, or as an immobile landscape through which the listener travels. The book deals mostly with the first metaphor.

Larson depicts three forces that shape music: **gravity, magnetism and inertia**

By gravity he means the (alleged) tendency of a melody to descent which he thinks is universal to all music. The melody is pulled down by gravity.

Magnetism is a force that pulls unstable pitches to the closest stable one. Stable pitches are for him the notes of the current major or minor triad. Although he has also included jazz improvisations in his analysis, he says nothing about chords that do not contain the notes of the major or minor triads (third and fifth). So, according to this part of the theory the sequence (in c major) e f must be followed by e again because e is closer to f (half-step) than g (full step) and thus has a stronger pull than g. However, the sequence e- f – g is still possible because of the third force: inertia.

Apart from stable and unstable pitches, he sees also stable and unstable beats. The downbeats are the stable ones and the upbeats are unstable. He also tells us that stable pitches can be found on stable beat and unstable pitches on unstable beats. Since he concludes that sequences try to reach stability we must ask what that means for backbeat compositions that necessarily end on an upbeat. Larson is quiet about this topic.

The third force is – as I have already mentioned – inertia. For Larson, inertia is the tendency of a musical pattern to continue in the same manner. Hence, an ascending sequence (e -f) will rise further.

All those forces are acting together all the time. Thus, he concludes that a down-down sequence is the most common because gravity and inertia work together. Up-up is the second most popular pattern because inertia is a strong force. The zigzag motions up-down and down-up are less used. This can also explained when seen through the lens of the music as physical motion metaphor. Music is an agent and we expect it to show determination. It should try to reach a goal. Zigzag movements are seen as lacking in determination.

Changes in direction happen through leaps while movements in the same direction

tend to step up or down. Leaps can be imagined as real physical motions. You bend your knees before you leap upwards and you also bend your knees to cushion the impact of the landing on a downward jump. Hence, the melody goes down before it leaps upwards and it lands on a note below the stable pitch on a downward jump. This disagrees somewhat with the theory that zigzag motions are not common.

Leaps are only done from stable positions as you would not jump from a shaky foundation in real world either. Stable positions tend to hold long notes while unstable positions favour short durations. He tells us that a half note on an upbeat is only allowed if it is tied to the first note of the next measure. I mused about this statement for five minutes (how can there be a half note on the second upbeat?) till I realized that I thought by instinct about backbeat music while he was not.

Another interesting insight was offered by him when he told us the perceived tempo of a sequence is influenced by the durations of the notes. A piece with short notes is perceived as faster than a piece with only long notes even though both have the same beats per minute.

In the second part of the book, he tries to harden his theory by evidence from the neurosciences. He says: “neuroscientists have also studied brain activation in those listening to music [] and their work suggests that melodic expectation and hearing basic rhythms activate the same part of the brain that is activated in the planning and execution of movement[].” The rest of the book offers quantitative analysis of musical pieces to back up his theories.

There are some points in the theory which I find incoherent but maybe I just have not understood it completely. At the end, he writes: [t]he theory claims that evenly paced patterns tend to change direction on the unstable pitches; when change in direction occur in stable pitches, however, those stable pitches tend to be rhythmically lengthened.” This conclusion seems to disagree with the leap subtheory discussed above. Leaps should only happen at stable pitches. Maybe he speaks at this point also of changes that do not include a leap. But then, such changes should not happen since a change is introduced by a leap. And leaps have to start from solid ground. I have already mentioned that the theory also is incoherent about the use of zigzag movements. Furthermore to meet criticism, he states that he has never argued that musical forces can explain all musical phenomena. Unexpected movements are one of the treats music is providing. So, I must conclude that the book is inspiring but not really convincing.

Outline

- short durations only on upbeats
- half note on the second upbeat must be tied to the next measure
- chord notes only on downbeats

- leaps from downbeats only to an unstable pitch below or above the target pitch
- unstable pitches (not in chord) only on upbeats
- inertia: up-up or down-down rather than up-down or down-up (except after leap)
- grouping of notes of the same duration

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